4. SITE BACKGROUND AND PHYSICAL SETTING

This section presents information on the regional and local physiography, geology, hydrology, meteorology, soils, ecology, and demographics and land use of the Waste Area Group (WAG) 10, OU 10-08 study area.

4.1 Physiography

The Snake River Plain (SRP) is the largest continuous physiographic feature in southern Idaho (Figure 4-1). This large topographic depression extends from the Oregon border across southern Idaho to Yellowstone National Park and northwestern Wyoming.

The SRP slopes upward from an elevation of about 750 m (2,500 ft) at the Oregon border to more than 1,500 m (5,000 ft) at Ashton northeast of the INEEL. The SRP is composed of two structurally dissimilar segments, with the division occurring between the towns of Bliss and Twin Falls, Idaho. The western segment (Western Plain) is a fault-bound graben filled with Tertiary sediments with minor basalt flows. The Eastern Plain is a subsidence basin in wake of the hot spot that is filled with basalt with a minor amount of sediments. West of Twin Falls, the Snake River has cut a valley through tertiary basin fill sediments and interbedded volcanic rocks. The stream drainage is well developed, except in a few areas covered by recent thin basalt flows. East of Bliss, Idaho, the Snake River locally, (near Twin Falls), carves a vertical-walled canyon through thick sequences of quaternary basalt with few interbedded sedimentary deposits. Elsewhere on the eastern SRP stream drainage is poorly developed and chaotic because of continual resurfacing by basalt lava flows.

The INEEL is located on the northern edge of the eastern SRP, a northeastern-trending basin, 80 to 110 km (50 to 70 mi) wide, extending from the vicinity of Bliss on the southwest to the Yellowstone Plateau on the northeast (Figure 4-1). Three mountain ranges bound the northern and northwestern boundaries of the INEEL: (1) the Lost River Range, (2) the Lemhi Range, and (3) the Beaverhead Mountains of the Bitterroot Range (Figure 4-1). Between the ranges and the relatively flat plain is a relief of 1,207 to 1,408 m (3,960 to 4,620 ft) (Hull 1989). The East and Middle buttes have elevations of 2,003 and 1,949 m (6,572 and 6,394 ft), respectively. Saddle Mountain, near the southern end of the Lemhi Range, reaches an altitude of 3,295 m (10,810 ft) and is the highest point in the immediate INEEL area.

The portion of the SRP occupied by the INEEL may be divided into three minor physiographic provinces. The first province is a central trough that extends to the northeast through the INEEL. This central trough is often referred to as the Pioneer Basin, or more recently referred to as the Big Lost Trough in various papers from the University of Idaho geology department. Two flanking slopes descend to the trough, one from the mountains to the northwest and the other from a broad ridge on the plain to the southeast. The slopes on the northwestern flank of the trough are mainly alluvial fans consisting of sediments of Birch Creek and the Little Lost River, and colluvial sediments shed off of the outcrops of the ranges mentioned above that bound the trough to the northwest. Also forming these gentle slopes that bound the trough are basalt flows that have spread onto the plain. The landforms on the southeast flank of the trough are formed by basalt flows, which spread from a volcanic zone that extends northeastward from Cedar Butte. The lavas that erupted along this zone built up a broad topographic swell (referred to topographically as the Axial Ridge of the eastern Snake River Plain and geologically as the Axial Volcanic Zone [Hackett and Smith 2000]), which caused the Snake River to flow in its current course along the southern and southeastern edges of the plain (Figure 4-2). The Axial Ridge of the eastern SRP topographic swell effectively separates the drainage of mountain ranges northwest of the INEEL from the main portion of the Snake River drainage.

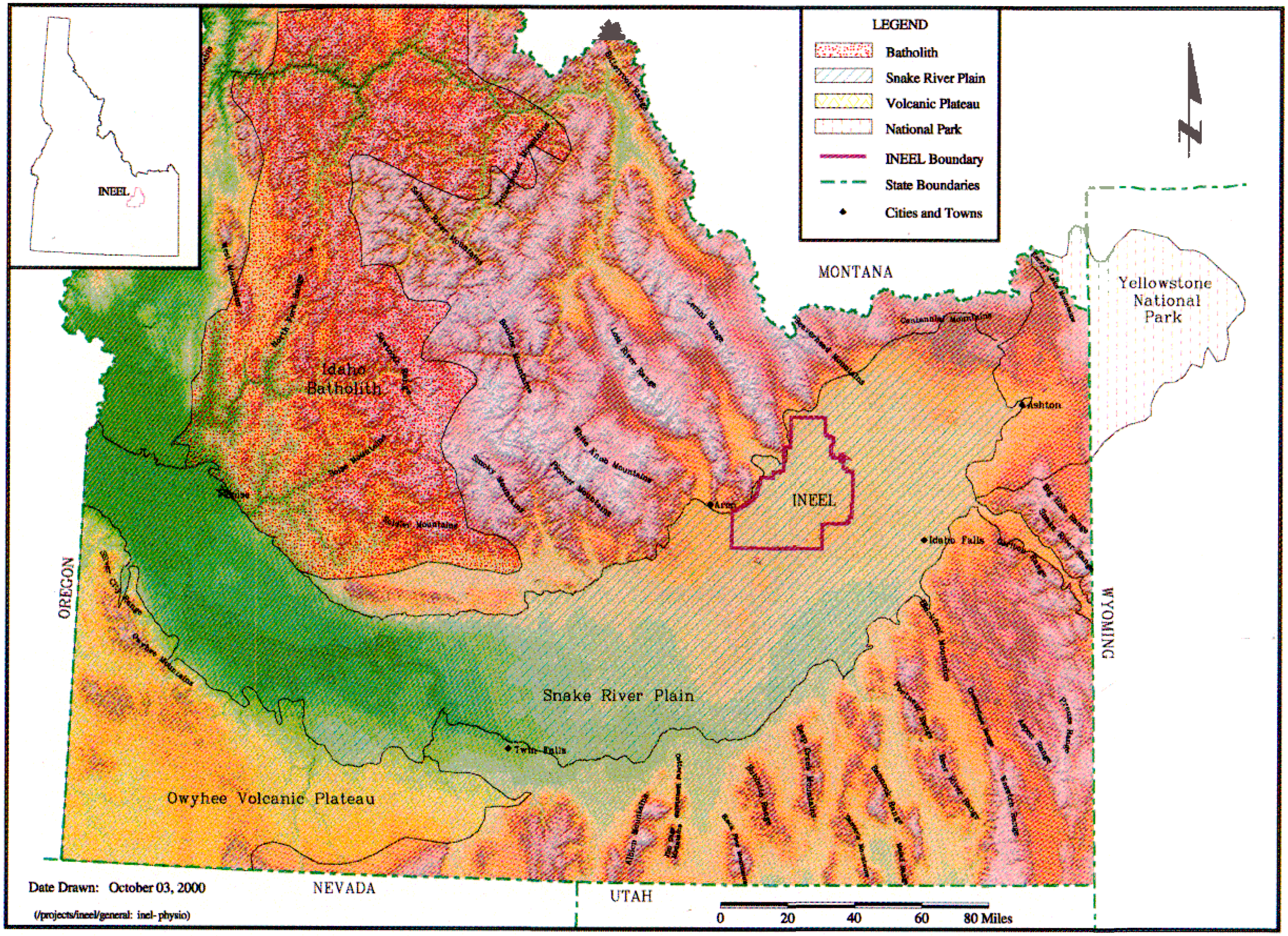

Figure 4-1. Physiographic and geologic features of the INEEL area.

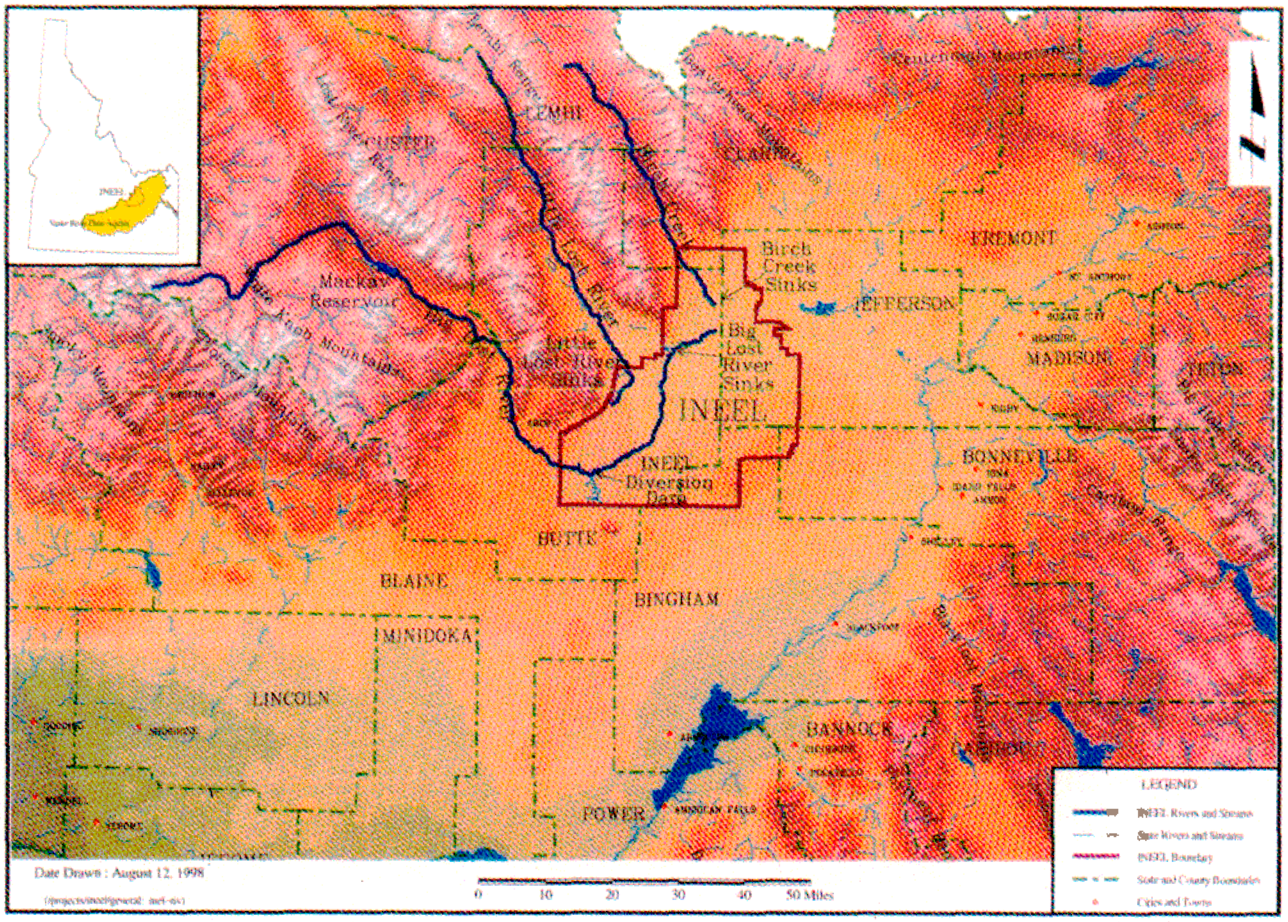

Figure 4-2. Locations of the Big Lost River, Little Lost River, and Birch Creek.

The Pioneer Basin of the INEEL broadens to the northeast and joins the extensive Mud Lake Basin. The Big and Little Lost Rivers and Birch Creek drain into this basin from valleys between the mountains to the north and west (Figure 4-2). The intermittently flowing waters of the Big Lost River have formed a flood plain in this trough, consisting primarily of gravel and sands with minor silt and clay. Streams flow to the Big Lost River and Birch Creek sinks, a system of playa depressions in the west-central portion of the INEEL, southeast of the town of Howe, Idaho. The sinks area covers several hundred acres and is flat, consisting of significant thickness of fluvial, pluvial and lacustrine (lake) sediments.

4.2 Geology

The Idaho National Engineering and Environmental Laboratory (INEEL) is located near the northwestern margin of the eastern Snake River Plain (SRP) and lies in an area influenced by two distinct geologic provinces. The eastern SRP is a northeast-trending zone of late Tertiary and Quaternary volcanism that transects the northwest-trending, normal-faulted mountain ranges of the surrounding Basin and Range province (Figure 4-3). The topographically subdued eastern SRP, the dominant geomorphic feature of southern Idaho, is a relatively aseismic region in the midst of the high-relief, seismically active Basin and Range province.

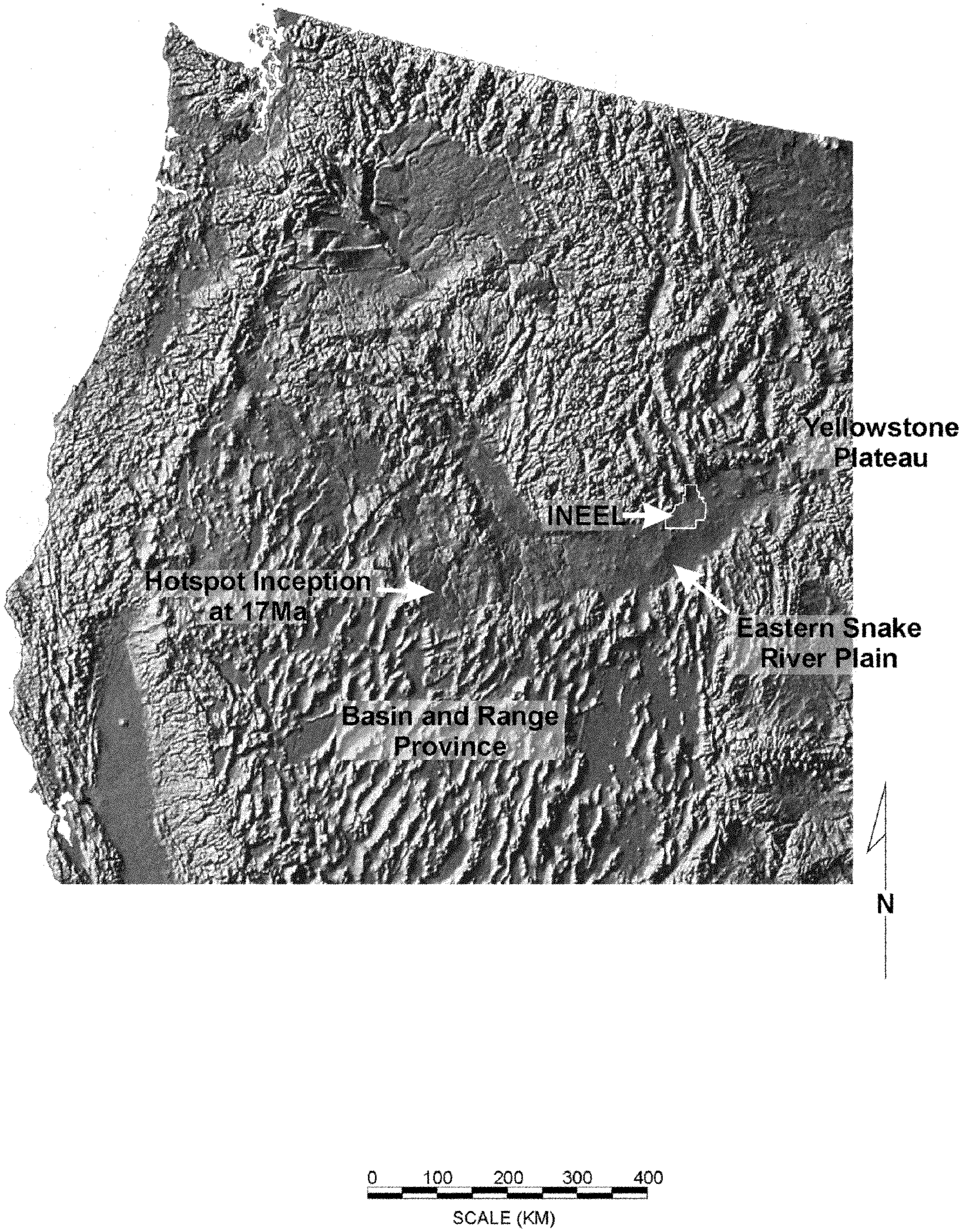

Figure 4-3. Digital topographic map of the western United States.

A unique set of geologic processes occurring in the last 5 to 10 million years formed the eastern SRP, allowed the accumulation of a thick sequence of volcanic rocks and sediments of the eastern SRP, and produced an ideal geologic, topographic, and stratigraphic setting for the Snake River Plain aquifer. These geologic processes have had a profound effect on the topography, geologic structure, volcanism, sediment accumulation, and hydrology of the region.

Volcanic and sedimentary rocks of the Snake River Plain form a 60 to 100-km-wide belt, extending about 600 km from the Idaho-Oregon border to the Yellowstone Plateau. Volcanic rocks consist of late Tertiary rhyolitic rocks and latest Tertiary to Holocene basaltic lava flows. At least 1 km of basaltic lava flows and intercalated sediments has accumulated in the eastern Snake River Plain following the rhyolitic volcanism related to passage of the Yellowstone mantle plume. About 2 km of subsidence of the Eastern plain in the past 4 million years have allowed the basalts and sediments to accumulate and have confined their emplacement and deposition to the current boundaries of the plain.

4.2.1 The Eastern SRP Basin

The subsurface materials of the eastern SRP are unique in several respects, and this is due to a unique set of geologic processes, which lead to their accumulation. The interaction of the Yellowstone hot spot (a rising plume of hot mantle material beneath the continent) with the crust is responsible for the unique character of the eastern SRP. Passage of the continent southwestward over the stationary hot spot has created an elongate volcanic province within the faulted, mountainous region of the northern Basin and Range province and the northern Rocky Mountains (Figure 4-1) (Pierce and Morgan 1992; Smith and Braile 1994). As the INEEL area of the eastern SRP passed over the hot spot at about 7 to 4.3 million years ago, the crust was heated and uplifted, and voluminous volcanism, characteristic of that seen at Yellowstone National Park today, created a sequence of rhyolitic lava flows and ash flows (Figure 4-4). The thickness of this sequence is up to several kilometers where encountered in a deep drill hole at the INEEL (Hackett and Smith 1992). The eastern SRP began to subside topographically after it moved off of the hot spot about 4.3 million years ago. Total subsidence of about 1.5–2 km was caused by the increased load of dense magmatic rocks emplaced in the middle crust and by contraction of crustal rocks during cooling. The northeast-elongate subsiding eastern SRP basin extends from the Twin Falls area on the southwest to the Yellowstone Plateau on the northeast, a distance of about 200 miles (Figure 4-1). It has filled with basalt lava flows that were erupted from numerous volcanic vents throughout the eastern SRP and by unconsolidated sediments deposited by water and wind. This sequence of basalts and sediments covers the older rhyolitic volcanic rocks to depths of about 1 km in several deep drill holes in the INEEL area.

The continuing subsidence coupled with the eruption of basalt lava flows and accumulation of sediments produces the low relief and low elevation character of the surface of the eastern SRP. Tectonic processes, including uplift of the Yellowstone Plateau above the mantle hot spot and normal faulting in the northern Basin and Range Province, maintain the high elevations and mountainous character of the region surrounding the eastern SRP.

4.2.2 Quaternary Basalt, Sediment, and Rhyolite

Basalts and sediments of the eastern SRP are part of the Snake River Group, composed largely of tholeiitic-basalt lava flows emplaced during the past 4 million years (Figure 4-3). Most eruptions were effusive, and typical landforms of Quaternary mafic volcanism on the eastern SRP are small shield volcanoes with summit pit craters, fissure-fed lava flows associated with zones of tensional fracturing, and relatively uncommon tephra cones of magmatic or phreatomagmatic origin (Greeley 1982).

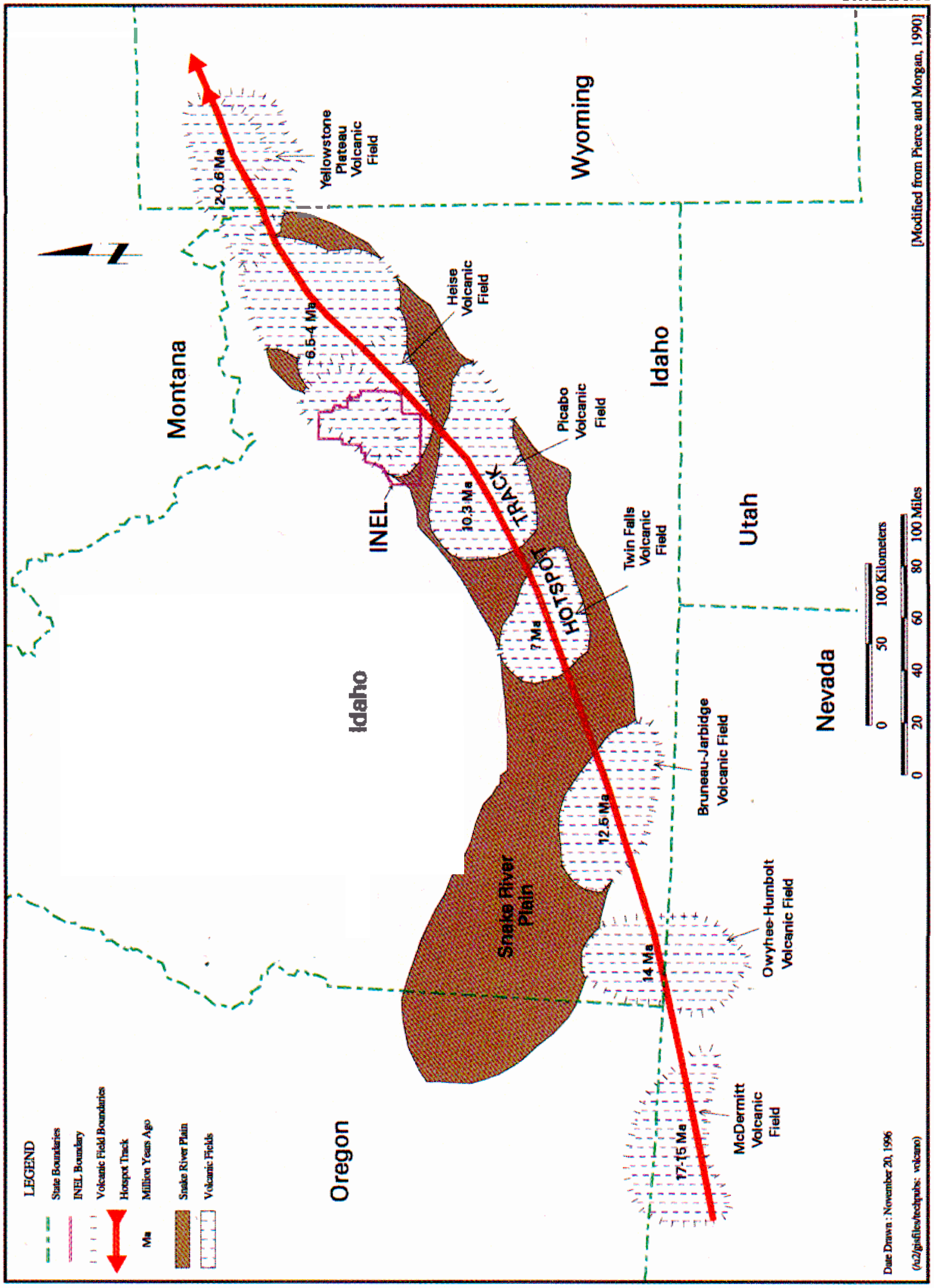

Figure 4-4. Yellowstone Plateau hot spot track and resulting volcanic fields.

Based on field mapping, and limited geochronometry and paleomagnetic data, (Kuntz et al. 1990) identified five Quaternary basalt lava-flow groups in the INEEL area, ranging in age from 5,200 years to greater than 730,000 years. Basaltic vents on the eastern SRP typically form linear arrays of fissure flows, small shields and pyroclastic cones, pit craters, and open fissures, which collectively define northwest-trending volcanic rift zones (see Figure 4-5). Volcanic rift zones have similar trends as normal faults in the adjacent Basin and Range province to the north, but are not strictly co-linear with those faults. The most well-known and recently active of eastern SRP volcanic rift zones is the Great Rift (Kuntz et al. 1988), where eight eruptive episodes occurred at Craters of the Moon, and several smaller, monogenetic lava fields were formed during the past 15,000 years. In the INEEL area, most basaltic rift-zone volcanism seems to have occurred during Pleistocene time, generally between about 0.1 and 0.7 Ma. Most subaerially exposed lavas have normal magnetic polarity and are, therefore, younger than about 730,000 years. Several well-dated Holocene lava fields (Kuntz et al. 1986) erupted from northwest-trending fissures to the south of the INEEL, on the northeast-trending axial volcanic zone.

4.2.3 Quaternary Surficial Deposits and Sediment Interbeds

Most lava flows at the surface in the INEEL region are Pleistocene in age, have been subaerially exposed for several hundred thousand years, and are, therefore, blanketed with unconsolidated sedimentary deposits of eolian, alluvial, and lacustrine origin (Scott 1982) (see Figure 4-6). Though little is known of the detailed Quaternary lithostratigraphy of the eastern SRP subsurface, data from INEEL drillcores (Figure 4-7) generally indicate that relatively long (10^5-year) periods of sedimentation and volcanic quiescence, represented by major sedimentary interbeds, were punctuated by relatively brief ($<10^2$- to 10^3-year) episodes of basaltic volcanism, the latter represented by rapidly emplaced lava-flow groups (Kuntz and Dalrymple 1979; Kuntz et al. 1979, 1980; Champion et al. 1988; Anderson and Lewis 1989; Anderson 1991). The present distribution of surficial deposits is probably qualitatively analogous to that of subsurface deposits, involving intermittent blanketing of lava flows by loess, and the deposition of fluvial/lacustrine sediments in low-lying areas between constructional volcanic zones.

4.2.4 Alluvial Deposits

Alluvial deposits of two types are found in the INEEL area: alluvial-fan deposits and mainstream alluvium. Alluvial fans are developed on the steep lower flanks of basin-and-range mountains and contain clastic material of local origin, commonly subangular/subrounded, moderately sorted gravel, dominated by Paleozoic carbonate clasts.

Mainstream-alluvial deposits are associated with the channels of the Big Lost River, Little Lost River, and Birch Creek, which longitudinally drain the northern Basin and Range province and flow southward onto the eastern SRP (Pierce and Scott 1982). None of these streams reaches the Snake River to the south. Instead, their ephemeral waters percolate into permeable lava flows and sediments at the Lost River Sinks of the northern INEEL, a local recharge area for the Snake River Plain Aquifer. Mainstream deposits are generally better sorted, rounded, and bedded than those of alluvial fans, and clasts are predominantly limestone, quartzite, chert, silicified Eocene volcanic rocks, and other resistant lithologies.

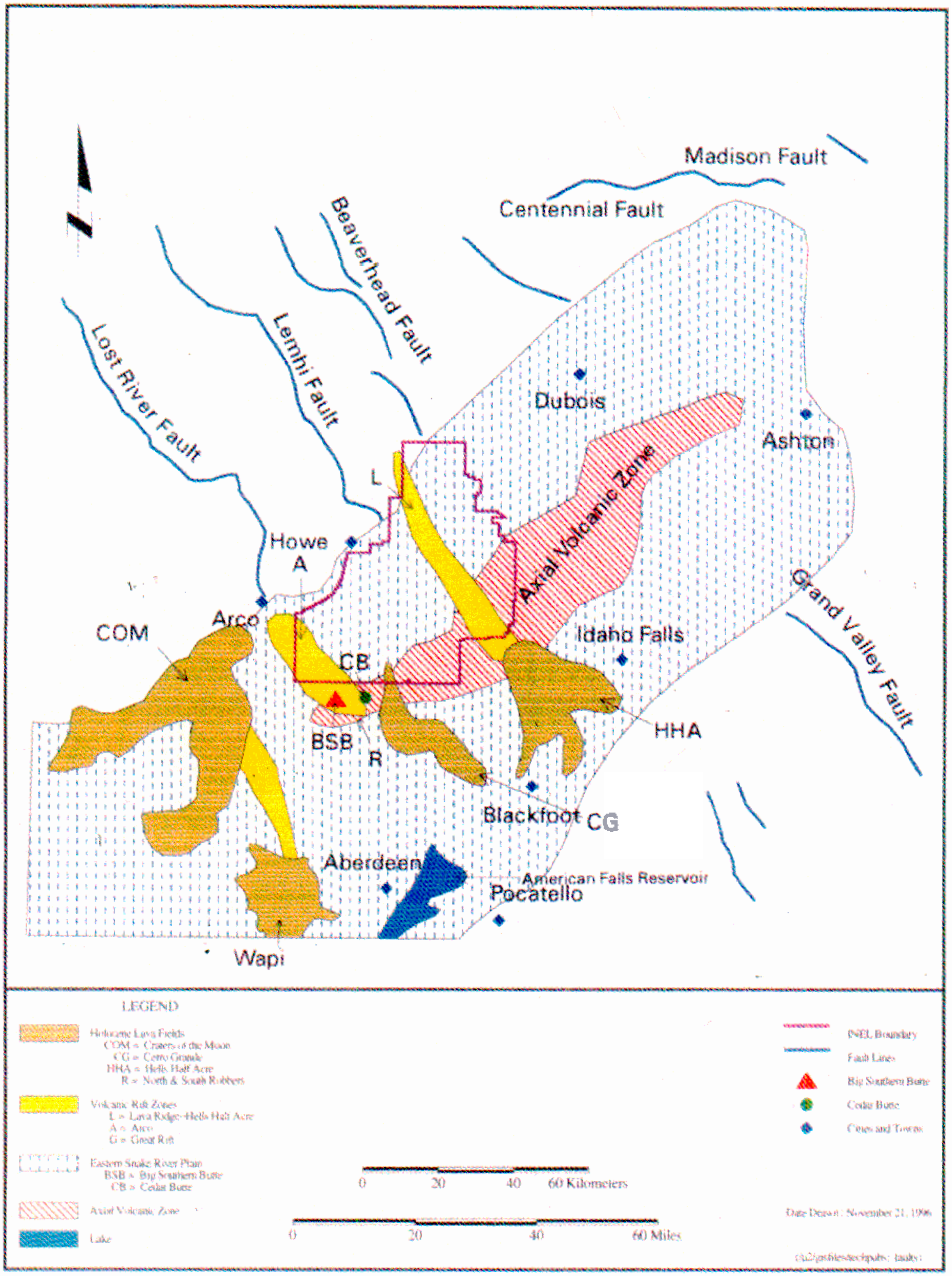

Figure 4-5. Illustration of the axial volcanic zone.

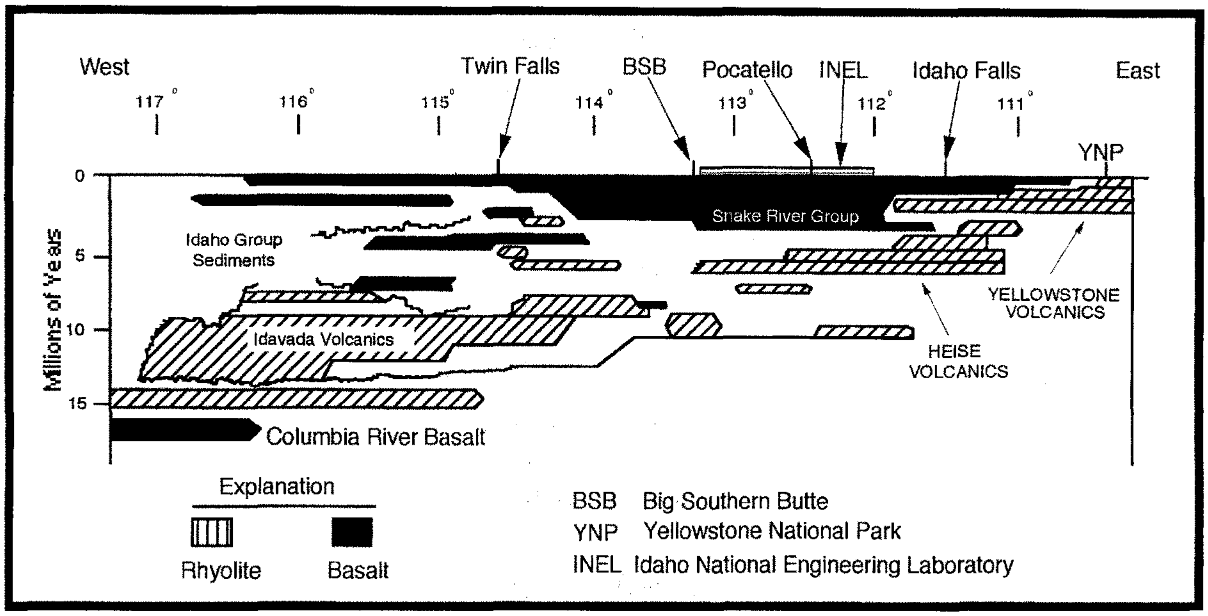

Figure 4-6. Surficial sediments and basalt outcrop at the INEEL.

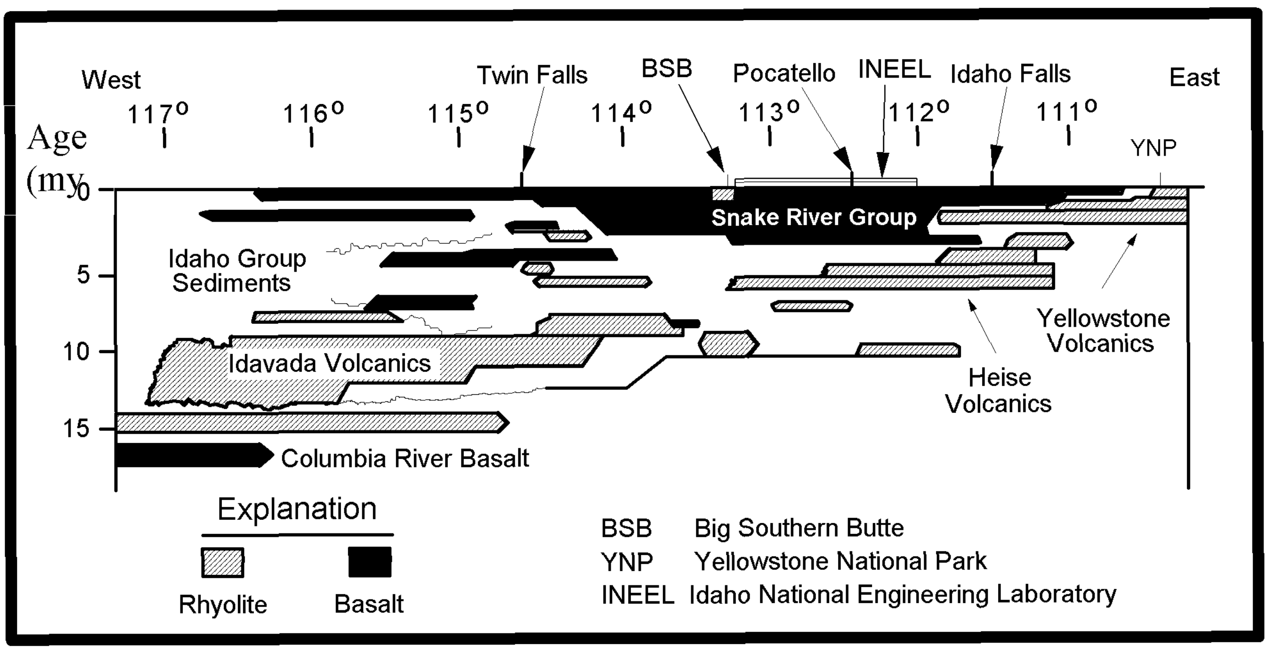

Figure 4-7. Diagram of age versus longitude for Snake River Plain volcanic rocks (modified from Armstrong et al. 1975).

4.2.5 Lacustrine Deposits

Volcanic eruptions and tectonism have periodically impounded the Snake River and its tributaries, forming lacustrine basins or areas of impeded drainage (Malde 1982; Howard and Shervais 1982, Scott et al. 1982, Hackett and Morgan 1988). In the INEEL region, the axial volcanic zone obstructed drainage from areas north of the eastern SRP. During glacial/fluvial periods, the resulting basins received more runoff than now, and contained large shallow lakes, in contrast to the present small playas of the Lost River Sinks. One such basin in the area that is now the northern INEEL was occupied by Lake Terreton, whose Pleistocene deposits have been cored in the upper part of Drillhole 2-2A (see Figure 4-8). Lake Terreton formerly covered a wide area near the present Mud Lake. Its shoreline generally follows the 4,800-ft topographic contour on the eastern SRP and is marked by beaches, bars, and deltas. Lake Terreton's sediments are the major source of material for Holocene dunes to the northeast.

4.2.6 Eolian Deposits

Pleistocene loess deposits are widespread on the eastern SRP and reach their greatest thickness along its southeastern margin. Eolian (windblown materials) deposits occur throughout the INEEL, and in fact, throughout the entire eastern SRP (Scott 1982, Kuntz et al. 1994). Several episodes of loess deposition are inferred from studies of loess stratigraphy and paleopedology (Pierce et al. 1982, Lewis and Fosberg 1982, Scott 1982). They are composed mostly of silt (loess) and fine sand. Within the area of basalt lava flows, some areas are covered by loess accumulations up to several meters thick, especially on the leeward sides of hills and ridges. These deposits tend to subdue the rugged, irregular topography of the lava flow surfaces and furnish a suitable medium for vegetation growth. Since loess deposition has been an active process throughout the subsidence history of the eastern SRP, most of the thin interbeds within the basalt sequence are composed of loess. This is especially true of the highlands along the Axial Volcanic Zone and along some volcanic rift zones where stream or lakes have never been present. Eolian deposits are also prominent in north-central INEEL, as linear sand dunes covering parts of the older lake bed deposits.

4.2.7 Contemporary Geologic Processes

Within the eastern SRP region, the area including the Yellowstone Plateau and the northern Basin and Range province that flanks the eastern SRP, several geologic processes could affect the INEEL facilities. These are subsidence of the eastern SRP itself, faulting in the northern Basin and Range Province, and volcanism on the eastern SRP.

Subsidence at a rate of about 0.5 mm/year is occurring on the eastern SRP (Smith et al. 1994) and continues to maintain the low elevation of the plain with respect to the surrounding mountains. The subsidence, coupled with the closed-basin watershed of much of the northwestern part of the eastern SRP, ensures a continued net accumulation of sediments and lavas.

Faulting is an ongoing response of the crust in the Great Basin, the eastern SRP, and the northern Basin and Range province to extensional deformation of the western United States. The extension direction in the eastern SRP region is northeast-southwest, and the southeastern Idaho area extends at a rate of 2 to 3 cm/year (Rodgers et al. 1990). The northern Basin and Range province accommodates the extension by normal faulting (also known as block faulting), which produces north to northwest trending mountain ranges (Figures 4-1 and 4-6). The Lost River and Lemhi ranges are classic examples of the block faulting process. They are over 100 km long and 20 to 30 km wide; are separated from each other by long narrow valleys (or basins) that are also about 20 km wide. Each of the ranges is bounded on its southwest side by a normal fault along which episodic faulting (and earthquakes) allows the basin to subside and the mountain range to move upward in response to the persistent extension of the region. The Lost River and the Lemhi faults, being the closest major faults to the INEEL, contribute a major part of the seismic hazard to facilities.

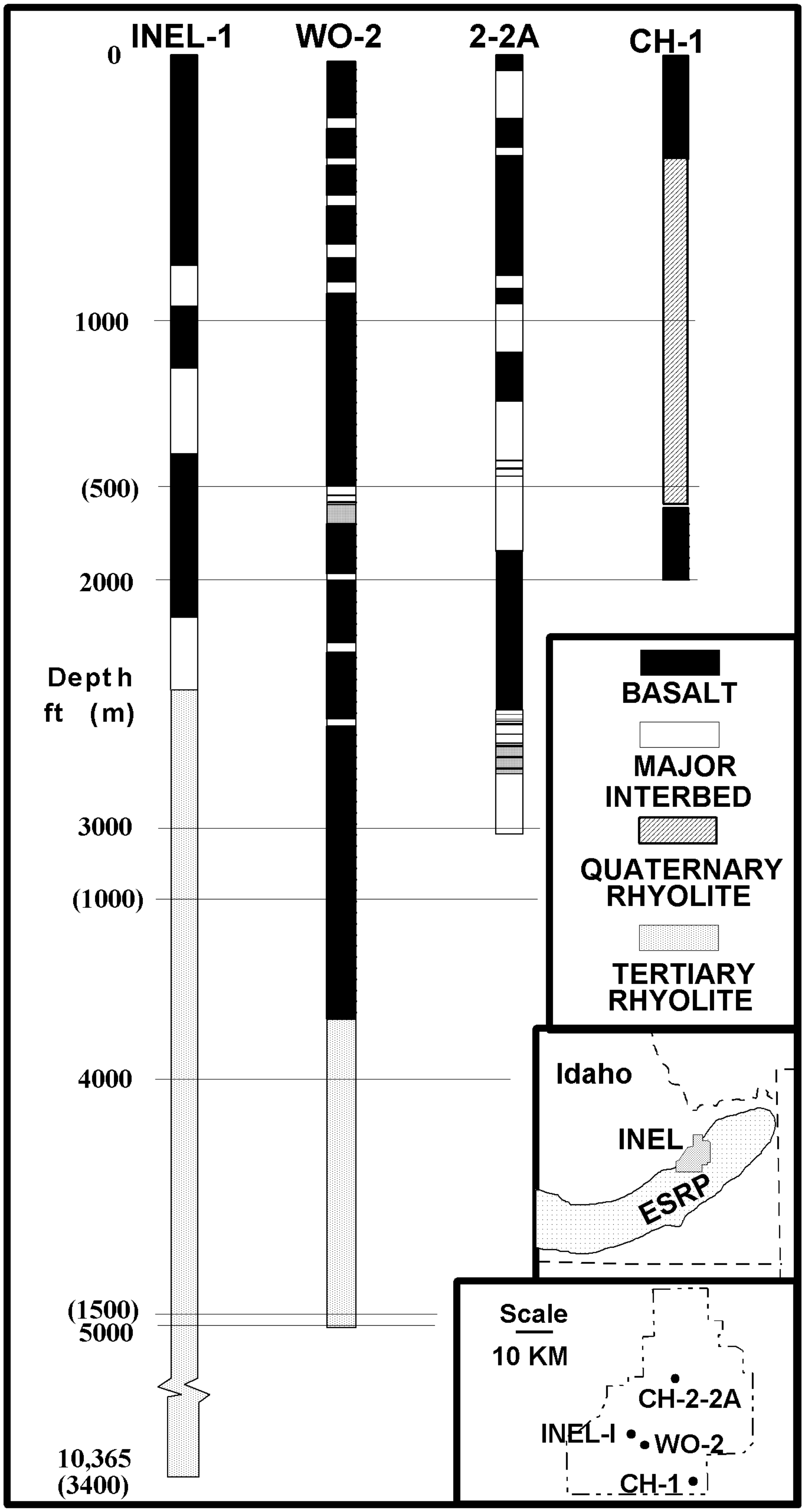

Figure 4-8. Lithologic logs of four deep INEEL drillholes.

Basaltic volcanism is a continuing phenomenon on the eastern SRP, most recently occurring about 2,000 years ago along the Great Rift, 30 km south of the INEEL. Since passage of the Yellowstone hot spot from the eastern SRP, residual heat in the upper mantle continues to cause local melting. At times, batches of basaltic magma accumulate to volumes large enough to allow upward movement in dike-like conduits to the surface. Because the dikes respond to the same extensional stress field as the normal faults outside the eastern SRP, they orient themselves into a northwest trend (that allows them to do minimal work in pushing the walls apart since the crust is extending in a northeast direction). The intrusion of northwest-trending dikes in the eastern SRP volcanic rift zones accommodates the extension of the plain and allows it to keep pace with the surrounding Basin and Range extension without normal faulting and large earthquakes (Parsons and Thompson 1991, Parsons et al. 1998). Batches of magma tend to rise in preferred areas, producing northwest-trending volcanic rift zones, such as the Great Rift and the Arco volcanic rift zones (Figure 4-6) (Kuntz et al. 1992, Hackett and Smith 1992).

Several eruptions tend to be clustered in time, with long periods of quiescence between clusters. For instance, in the Great Rift volcanic rift zone 8 eruptions have occurred within the past 15,000 years, but the lavas onto which the eruptions occurred are several hundred thousand years old. Relatively recent volcanism has also occurred at the southern end of the Arco volcanic rift zone (the Cerro Grande, North Robbers, and South Robbers flows near Big Southern Butte are a little over 10,000 years old) and just outside the southeast corner of INEEL (the Hells Half Acre lava field is about 5,000 years old) (Figure 4-6). In contrast to the time-progressive northeastward migration of older silicic volcanism related to passage of the Yellowstone hot spot, there appears to be no pattern of spatial migration of basaltic volcanic centers with time on the eastern SRP. Eastern SRP basaltic volcanism is characterized by low-volume, effusive eruptions in which lava flows from fissures or small shield volcanoes. Because of the gentle slopes on the eastern SRP surface and the relatively low effusion rates of lava, the advance of lava flows across the landscape is slow, usually at rates of a few meters per hour or less.

The U.S. Geological Survey (USGS) in their publication "Geologic Controls of Hydraulic Conductivity in the Snake River Plain At and Near the Idaho National Engineering and Environmental Laboratory, Idaho" (U.S. Geologic Survey Water-Resources Investigations Report 99-4033 by S. R. Andersen, Mel A. Kuntz, and Linda C. Davis) discussed and illustrated the possible formation of volcanic rift zones and associated flows. They also proposed that eruptions might have occurred along what they called Vent Corridors. Their discussion stated:

> "Volcanic Rift Zones and Vent Corridors
>
> Source vents for most basalt flows at and near the INEEL are concentrated in volcanic rift zones that trend perpendicular to the axis of the eastern Snake River Plain and parallel to the adjacent mountain ranges (Kuntz and others, 1992, Kuntz and others, 1994). Volcanic rift zones (Figure 4-9) are characterized by eruptive and noneruptive fissures, dikes, monoclines, faults, graben, and volcanoes having elongated slot-shaped vents (Rodgers and others, 1990; Kuntz, 1992; Kuntz and others, 1992; Smith and others, 1996). The distribution of volcanoes, dikes, and fissures is of hydrologic importance at and near the INEEL because these features are numerous and may greatly affect the range and distribution of hydraulic conductivity and the movement of ground water and wastes. Areas proximal to volcanic vents may provide localized, preferential pathways for ground-water flow. Dikes may impede the movement of ground water and diminish the hydraulic conductivity measured in nearby wells (Meyer and Souza, 1995; Hughes and others, 1997). Noneruptive fissures that parallel dikes may locally provide additional conduits for ground-water flow. Hydraulic conductivity of these fissures may be large because they cut across many

highly-permeable zones in and between individual basalt layers (Hughes and others, 1997; Welhan and Wylie, 1997).

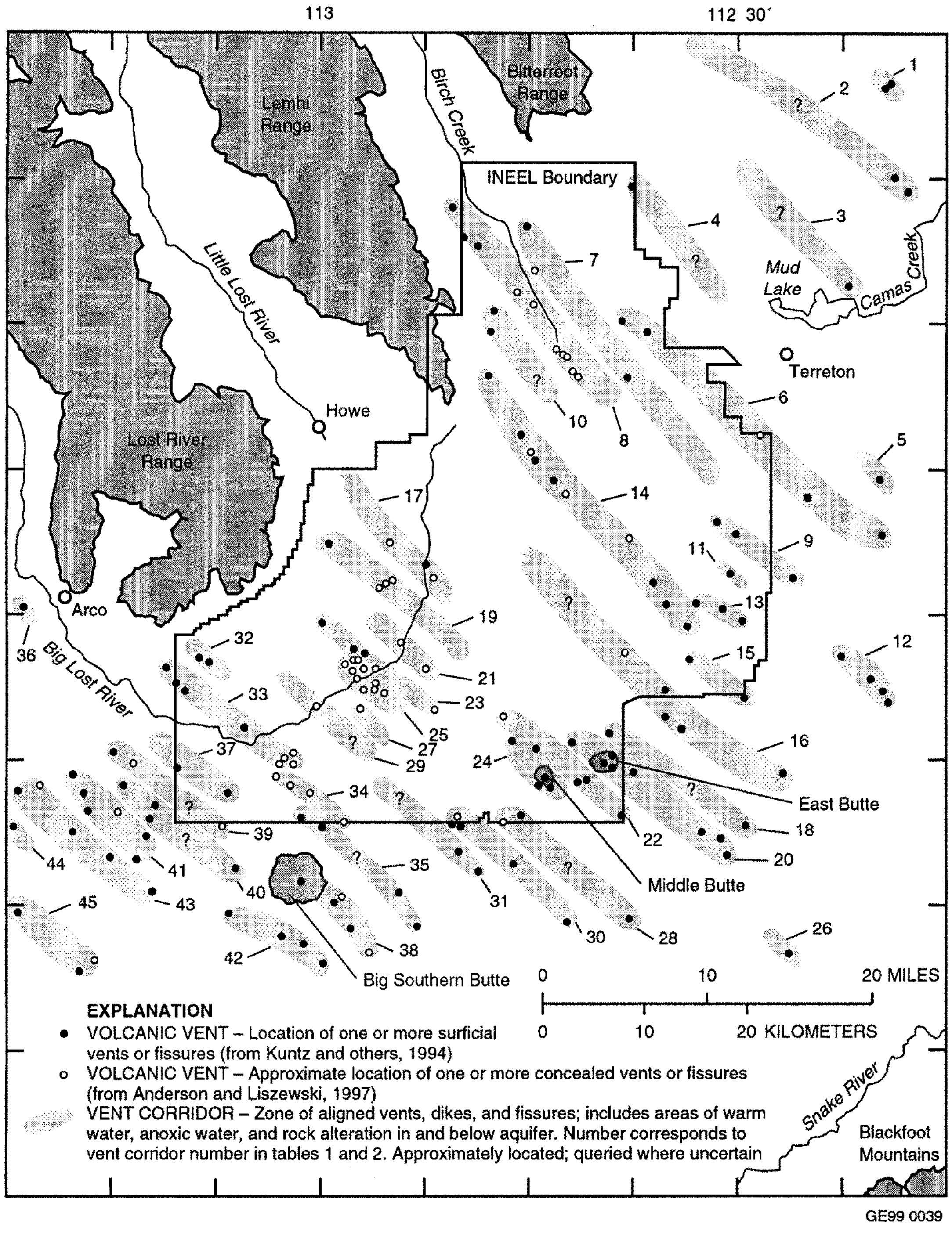

Figure 4-9. Approximate locations of volcanic vents and vent corridors.

Because fissures possibly extend upward into the aquifer from depths of several thousands of feet, some may provide local conduits for upward circulation of geothermal water from deep, underlying rocks into the Snake River Plain aquifer. This mechanism was suggested by Morse and McCurry (1997) to explain the abundance of alteration minerals observed in many drill cores. These alteration minerals locally diminish the hydraulic conductivity of basalt flows as shown by aquifer-test data (Mann, 1986) and water-temperature gradients in many deep wells that indicate conductive rather than convective heat flow within zones of pervasive alteration (Morse and McCurry, 1997). Conductive heat flow indicates poor ground-water circulation, whereas convective heat flow indicates active circulation. Zones of alteration generally occur below the effective base of the aquifer as defined by Anderson and Liszewski (1997). However, some zones extend into the aquifer and probably represent localized alteration in and near relatively young fissures.

The locations of vents, dikes, and fissures must be known or approximated to evaluate the relation between these features and hydraulic conductivity in wells at and near the INEEL. The locations of surficial vents are known from outcrop exposures (Kuntz and others, 1994; Hughes and others, 1997), and the locations of concealed vents were approximated by Anderson and Liszewski (1997, Figure 4-9) on the basis of interpreted stratigraphic relations at and near the INEEL. Most dikes and fissures are concealed and have not been identified in vertical cores; therefore, their distribution is uncertain. Dikes and open fissures are most likely to occur along and parallel to the trace of eruptive fissures marked by one or more vents.

On the basis of this likelihood, 45 zones of aligned vents, dikes, and fissures were approximated from the known and inferred locations of volcanic vents described by Kuntz and others (1994), Hughes and others (1997), and Anderson and Liszewski (1997). *These zones are herein referred to as vent corridors (Figure 4-10) to* distinguish *them from previously described volcanic rift zones.* Vent corridors 7 through 15 (Figure 4-9) roughly coincide with the Circular Butte-Kettle Butte and the Lava Ridge-Hells Half Acre volcanic rift zones mapped by Kuntz and others (1992). Vent corridors 19 through 24 and 33 through 39 roughly coincide with the Howe-East Butte and the Arco-Big Southern Butte volcanic rift zones, respectively. Vent corridors along the eastern and southern boundaries of the INEEL between corridors 5 and 42 roughly coincide with the area commonly referred to as the axial volcanic zone (Welhan and others, 1997)

Vent corridors (Figure 4-10) average about 1 to 2 mi in width and 5 to 15 mi in length, dimensions that are consistent with those predicted from geologic models of a string of dikes in the subsurface (Smith and others, 1996). The average orientation of vent corridors is about N.45°W, approximately parallel to the adjacent mountain ranges and perpendicular to the axis of the eastern Snake River Plain. Vent corridors contain vents of different ages, including many that are younger than the basalt flows in the aquifer (Anderson and Liszewski, 1997). Vent corridors 8, 23, 25, and 33 (Figure 4-9), which cover the TAN, TRA, ICPP, and RWMC may contain a large number of dikes and fissures. This assumption is based on the number and ages of concealed vents inferred in these areas (Anderson and Liszewski, 1997). In all areas, the number of dikes and fissures likely increases with depth. Individual dikes and fissures probably are no more than a few feet wide in most places (Smith and others 1996).

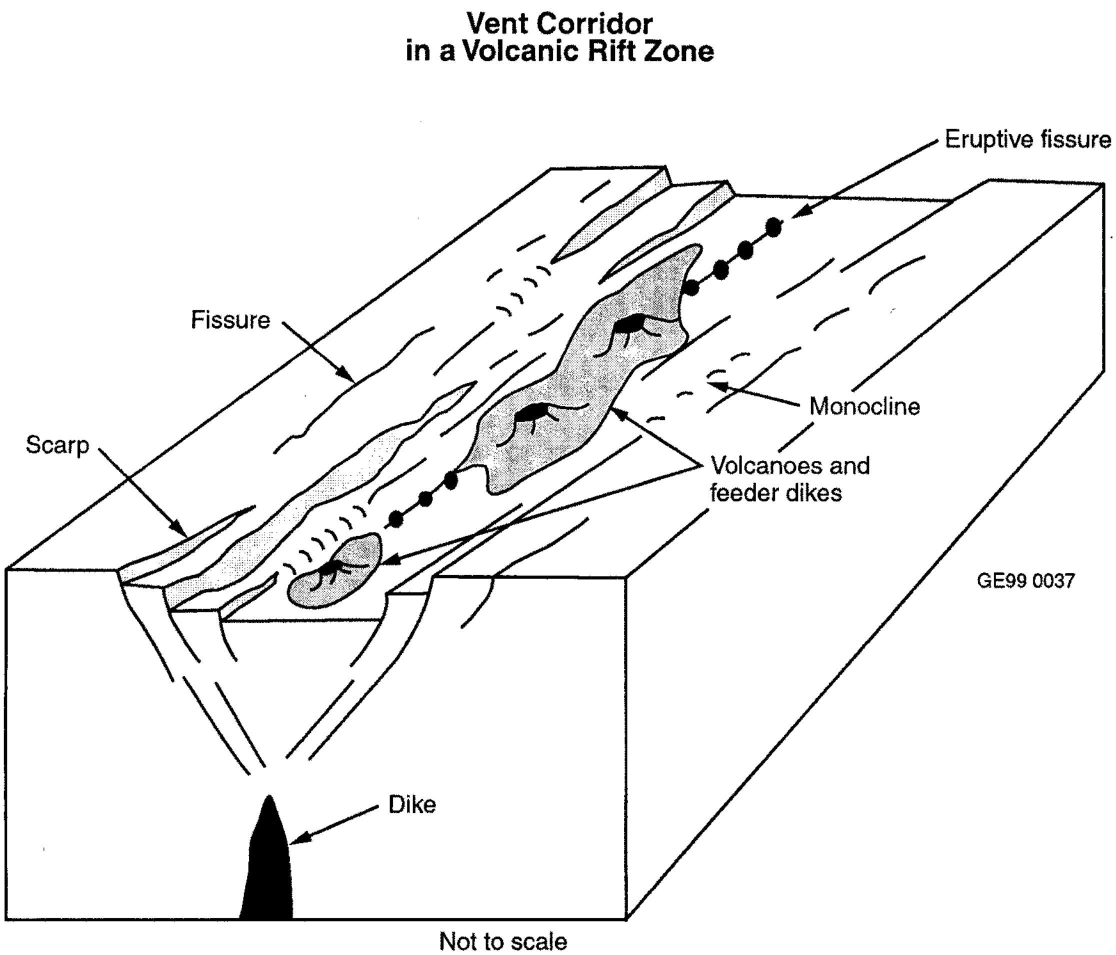

Figure 4-10. Illustration of hypothetical vent corridor.

Very few feeder dikes for the various types of volcanoes in the eastern Snake River Plain have been exposed because erosion is almost nonexistent. Therefore, the number and dimensions of feeder dikes in volcanic rift zones and vent corridors at and near the INEEL (Figures 4-9 and 4-10) is somewhat conjectural and must be estimated using what is known or can be reasonably inferred about basaltic dikes elsewhere on the eastern Snake River Plain. These estimates can be made from geologic maps of the Great Rift volcanic rift zone southwest of the INEEL (Kuntz and others, 1989a, 1989b, 1989c, 1992). Dikes are typically 1 to 4 ft wide, a few hundred feet to a few miles long, and of unknown vertical extent. In general, dikes on the eastern Snake River Plain are widely spaced geographically and are not concentrated within sheeted dike zones such as are common in Hawaii or in mid-oceanic ridges.

Dikes in volcanic rift zones in Hawaii and Iceland occur in swarms forming what is known as sheeted dikes. In such localities, parallel dikes are intruded so closely to one another that there is little, if any, country rock lying between the dikes. Because the dikes fill tensional fissures, sheeted dikes demonstrate that the fissuring is concentrated within a relatively narrow zone.

The exception to the generalization of widely spaced dikes in the eastern Snake River Plain is along the Great Rift volcanic rift zone, where several to a few tens of dikes may be in close contact over horizontal distances of 100 ft to several miles. That there may be other exceptions to this generalization is suggested also by the number and proximity of inferred vents concealed beneath some areas at the INEEL, such as in vent corridors 23 and 25 at and near the ICPP and TRA (Figure 4-9). In these areas, the number and spacing of dikes may be similar to those of the least concentrated dike swarms in Hawaii and Iceland."

4.2.8 Local INEEL Geology

Major geologic units in the INEEL area include basalt lava flows, fluvial sediments along the Big Lost River, lacustrine (lake) sediments in the northern and northeastern parts of INEEL, sediments deposited in playas (ephemeral lakes that have water only during parts of the year or once in several years), and eolian sediments (windblown silt and sand) (Figure 4-11) (Kuntz et al. 1992, Kuntz et al. 1994, Hackett and Smith 1992). Basalt lava flows, ranging in age from over a million years to less than 15,000 years, outcrop over most of the site. They generally lie in topographically high areas that stand above the Big Lost River floodplain. The volcanic vents for these lava flows occur in the northwest trending volcanic rift zones and along the northeast trending axial volcanic zone as discussed above (Figure A-8).

Several different sedimentary environments exist on the INEEL. Strong subsidence in the north-central part of the site, in a broad area that includes the Big and Little Lost River sinks and Test Area North (TAN), has produced a persistent low closed basin, which contained a large lake (Lake Terreton) or perhaps several lakes during Pleistocene glacial periods. Clay-rich and silty lake sediments have accumulated to thicknesses of about 100 meters in some places and make up all or most of the vadose zone in these areas.

In a broad north-trending band along the course of the Big Lost River, the major sedimentary process has been deposition of gravely and sandy alluvium along the floodplain of the river. The thickness of this alluvium ranges from a few feet to 60 ft or so along the reach of the river from Central Facilities Area (CFA) to Naval Reactors Facility (NRF). North of NRF a transition zone exists, where the sandy and gravely alluvium grades into and interfingers with the clay-rich and silty playa and lake sediments to the north. Some of the interbeds at depth beneath the alluvial floodplain probably are also composed of alluvial materials similar to those at the surface, but few drill holes have produced core samples to verify this speculation. Major INEEL facilities have been constructed along the Big Lost River, mainly because of the ease of excavations in the alluvium for foundations.

Low areas with relatively large local watersheds commonly are sites of frequent collection of meltwater in springtime and stormwater in summer. The runoff from these local watersheds commonly deposits clay and silt in the low spots during times of water ponding to produce playas. Subsequent soil-forming processes and evaporation of ponded water often add calcium carbonate deposits (caliche) to the material. Important playas include the Radioactive Waste Management Complex (RWMC) spreading areas, Rye Grass Flats just southeast of CFA, a small playa near the Power Burst Facility (PBF), the Big and Little Lost River Sinks, the TAN area, and a small area near the eastern boundary of the INEEL (Kuntz et al. 1994).

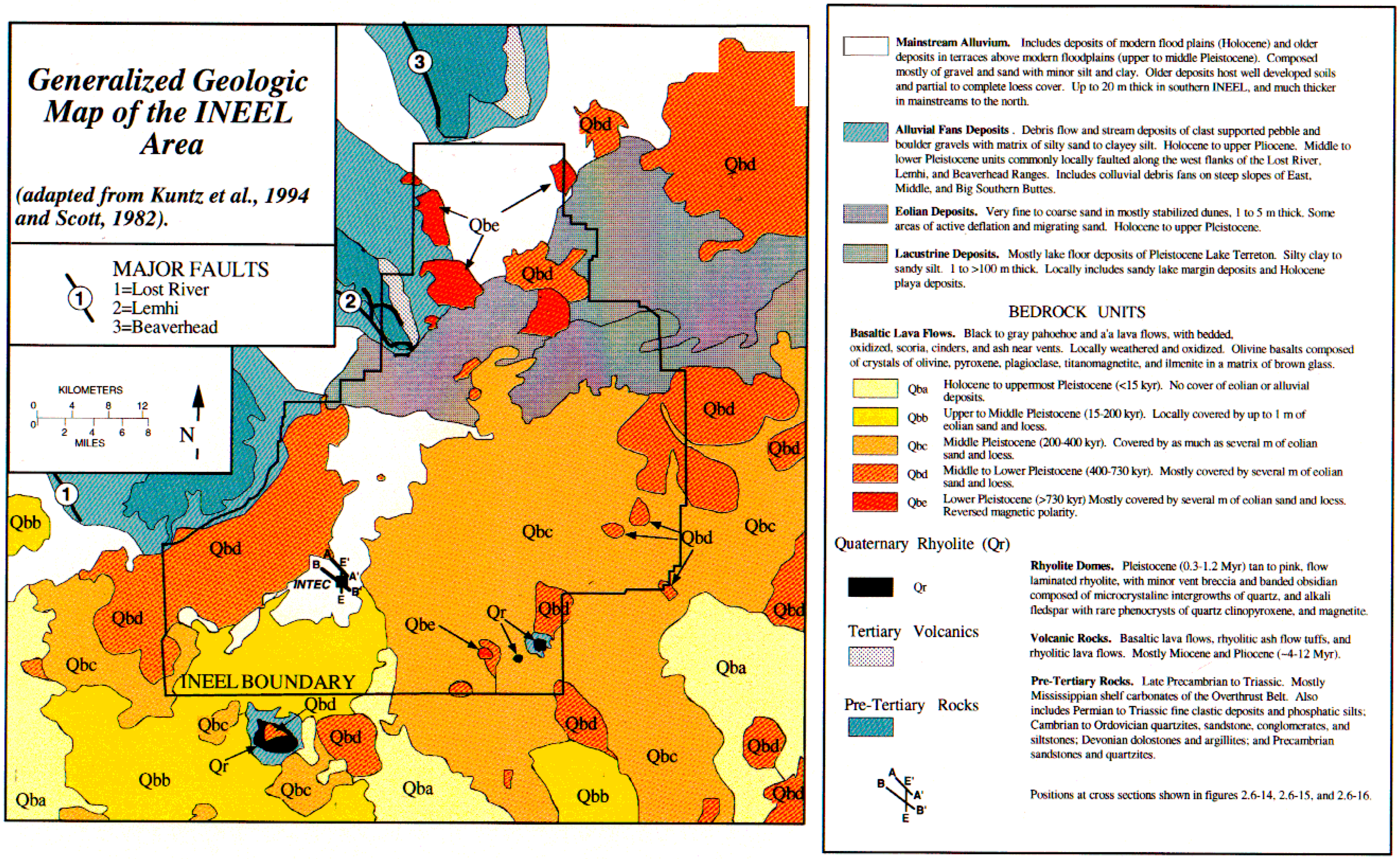

Figure 4-11. Geologic map of the INEEL area showing five Quaternary lava-flow groups.